HALDIMAND COUNTY

DESIGN CRITERIA

SECTION H

STORM WATER MANAGEMENT AND DRAINAGE

Revised 2015

H 1.00 STORM DRAINAGE POLICY

H 1.01 QUANTITY CONTROL

FLOOD MANAGEMENT CRITERIA

All newly developing or redeveloping areas must assess their potential impacts on local and regional flooding (minor and major events), and mitigate accordingly.

DESIGN

In areas where no Watershed or Sub-watershed Planning or Subwatershed Impact Study has been completed, it is the policy of Haldimand County to require that runoff peak flows are controlled to pre-development levels for the 2 year through 100 year events, unless the proponent can demonstrate through appropriate modeling and analysis that uncontrolled flow will not cause detrimental impacts on flood conditions on downstream properties and watercourse systems. Before the County will accept any increase in runoff rates, it must also receive endorsement from the other agencies having jurisdiction.

Where the Subwatershed Plans or Subwatershed Impact Studies have been completed, the development proponent will be required to comply with the recommendations of the specific plan. Any variations will need to be appropriately supported by detailed analysis and also be approved by any agencies having jurisdiction.

All design submissions shall contain a statement from the designer indicating which Best Management Practices have been reviewed and utilized in the design of the Stormwater management system for the proposed development.

Any design of a flood management system involving the determination of peak flows or runoff volume needs to be supported with acceptable hydrologic calculations using rainfall information from the County. The following criteria would apply:

- Only hydrologic models currently approved by MNR will be considered acceptable;
- Consideration will be given to the type of design methodology utilized dependent upon the size and type of the site. Generally, computer models will be preferred;
- The County's IDF information and design storms are to be used; and

- Storm sewers and open channels can be designed using the Rational Formula; all other flood management components will require a hydrograph technique.

EROSION CONTROL

CRITERIA

Depending on the downstream water level and the nature of the soil strata affected, stream banks can be subject to increased erosion - potential as a result of development. In these cases the proponent(s) will be required to provide appropriate protection in accordance with the Watershed or Sub-watershed Plans or with local drainage studies, as well as policies of governing Conservation Authority.

In areas where no Sub-watershed Plan exists, it shall be the responsibility of the development proponent to provide adequate erosion protection in accordance with Provincial Guidelines, unless it can be demonstrated through appropriate modeling and/or analysis that erosion processes will not be adversely affected by the proposed development.

DESIGN

Erosion Control and management involves: -

- Extended Detention storage for the 25mm rainfall event as outlined in the Provincial Guidelines (ref. SWM Planning & Design Manual, MOE, 2003), in the absence of specific direction from a Sub-watershed or Watershed Plan;

- Assessment of downstream erosion susceptibility and critical flow values in conjunction with event modeling; and

- Assessment of downstream erosion critical velocity or shear forces in conjunction with continuous simulation techniques (duration analysis).

In areas where the downstream receiving watercourse is determined to be unstable, or where control/over control of flow rates is ineffective or not feasible, design of channel alterations may be considered, subject to design in accordance with natural channel design principles (ref. Ministry of Natural Resources, 2001 or most current).

Storm sewer outfalls in natural channels should be provided with proper protection against erosion which includes appropriate bank scouring protection on either side of the outfall and creek. When storm sewer outfalls outlet to steep and/or deep valleys, drop structures should be

designed so as to provide integral bank stability. Such local erosion protection measures should be designed so as not to interfere with the natural channel forming processes of the receiving watercourse system.

CONVEYANCE SYSTEM (I) MAJOR SYSTEM

CRITERIA

Flows in excess of the minor system capacity (i.e. during periods of surcharging or higher intensity events) are referred to as major system flow. The major system inherently comprises the minor system, as well as the overland route followed by runoff not captured by the minor system (i.e. either due to excessive flow or operational failures). Common elements of the major system include natural streams, valleys, swales, ponds, roadways, dedicated blocks and drainage channels.

The level of protection should be established based the nature of the area drained (i.e. risk to loss of life and property damage).

DESIGN

Haldimand County supports the policies of the local Conservation Authorities, which generally require that no new building be subject to flood damages from the Regulatory flood as per the revised Technical Guidelines for Flood Plain Management in Ontario (February, 1986). The Regulatory flood is the greater of the Hurricane Hazel flood (transposed), modeled 100-year flood, observed flood, or frequency-based 100-year flood.

No development, other than necessary access or services, should intrude upon Hazard Lands without the approval of the local Conservation Authority, and Haldimand County. In conjunction with this objective, the County shall require the Development Proponent to delineate floodplains in a proposed development resulting from the 100-year and Regional Storm for both the pre- and post-development conditions.

Major overland flooding should not exceed 150mm depth over the crown during a 100-year event for any roadway and should remain within the designated right-of-way. Blocks dedicated through easement or ownership to the County will be required to convey overland flow from roadways to open watercourse systems. These blocks should be designed for stability and safety to the satisfaction of the Haldimand County.

CONVEYANCE SYSTEM (II) MINOR SYSTEM

CRITERIA

The minor system (commonly referred to as the convenience system) handles urban drainage from relatively "minor" storms having a frequency (return period) of 5 years. These works typically consist of drainage pipes, roadway gutters and swales, enclosed conduits and roof leaders. Their purpose is to prevent frequent flooding which may "inconvenience" motorists, home and business owners, and pedestrians.

The County will not allow development to proceed until adequate provision, in the form of storm sewers has been made available. Rural development will also require adequate provision for storm drainage, but it may not require storm sewers.

DESIGN

The minor or convenience system, comprising street gutters, catch basins and storm sewers, shall be designed to a 1 in 5 year un-surcharged standard. In some higher value commercial areas, the criteria may be increased to 1 in 10 year floods at the direction of the County Engineer.

Direct Connections of foundation drains to the storm sewers are not permitted. Connections of the foundation drains to the storm sewer will only be permitted in accordance with the specification/drawing shown at the end of Section 'I'. The County preference is that sump pumps be discharged to a splash pad immediately outside of the foundation wall.

H 1.02 QUALITY MANAGEMENT CRITERIA

Water quality treatment will be required for all new development within Haldimand County. Water quality treatment performance shall conform to Provincial requirements (ref. Stormwater Management Practices - Planning and Design Manual, MOE, 2003, Water Management Policies, Guidelines Provincial Water Quality Objectives (Blue Book), MOEE, 1994).

In areas of existing development where re-development is proposed, provisions for water quality measures will be evaluated on a site-specific basis, based on the feasibility of implementation. Where on-site measures are considered infeasible, Haldimand County may consider the potential for contributions to off-site improvements (i.e. cash-in-lieu), subject to agency concurrence. A master plan approach to compensation towards off-site works is advocated by the County.

In areas where a Sub-watershed Plan has been prepared and approved, the guidelines and criteria cited within the plan shall be adopted by the Development Proponent.

DESIGN

Specific guidelines for SWMP application have been developed by the Province based on the type of fisheries habitat downstream of the proposed development, as follows:

Three levels of protection are given, with the goal to maintain or enhance existing aquatic habitat, based on the suspended solids removal performance for the different end-of-pipe stormwater management facilities developed in the continuous simulation modeling. These levels of protection are based on a general relationship between the end-of-pipe stormwater management facilities long-term suspended solids removal and the lethal and chronic effects of suspended solids on aquatic life. The levels of protection correspond to the following long-term suspended solids removal:

Enhanced protection corresponds to the end-of-pipe storage volumes required for the long-term removal of 80% of suspended solids.

Normal protection corresponds to the end-of-pipe storage volumes required for the long-term removal of 70% of suspended solids.

Basic protection corresponds to the end-of-pipe storage volumes required for long-term removal of 60% of suspended solids.

As a general consideration, maintenance of the natural hydrologic cycle including infiltration is encouraged where soil conditions permit. Therefore the use of stormwater management practices which enhance or maintain infiltration should be considered for each development. Generally active infiltration measures will be applicable in permeable soils areas only and their use will require supporting soils documentation. Passive measures such as disconnection of roof leaders have been historically utilized in many areas and should be implemented as a matter of course in all areas unless specific constraints preclude theses measures.

In all cases, the potential for groundwater contamination shall be considered, particularly where infiltration of road runoff is contemplated.

In areas where hydrogeological concerns are identified and/or critical linkages to fisheries habitat are present, additional study and analysis may be required to determine the appropriate level of mitigation.

H 1.03 STORMWATER QUANTITY AND QUALITY CONTROL TECHNIQUES

H 1.031 GENERAL

Current stormwater management practice advocates the consideration of SWM Practices on a hierarchical basis, whereby more pro-active techniques are considered first. The SWM Practices are grouped under the following headings in order of preferred application:

(i) Lot Level Techniques and Source Controls and Alternative Development Standards;

(ii) Transport or Conveyance Controls; and

(iii) End-of-Pipe Management Techniques.

The philosophy behind this hierarchy is that stormwater management techniques are usually more effective when applied at the source. Table H1 constitutes a comprehensive list of currently available techniques associated with each of the foregoing categories. It is recognized that stormwater management remains an emerging science, hence this list will change over time. It will be the responsibility of the proponent to demonstrate that any technique, not currently approved by the County, will address the intended function within expected maintenance and cost parameters, to the satisfaction of Haldimand County.

Haldimand County currently endorses the Provincial Standards for stormwater management systems unless otherwise noted herein.

H 1.032 STORMWATER MANAGEMENT REPORT/PLAN MODELLING

Stormwater Management Report/Plan should provide all necessary maps showing the modeling sub-catchments, proposed facility etc. For each modelling sub-catchment, summary tables shall include (but not be limited to) the following components:

a) total drainage area;
b) pre and post-development impervious area;
c) pre and post- development areas of different surfaces and runoff coefficients for each ground cover element (rooftop, pavement/asphalt, gravel, grass, etc.);
d) total drainage area devoted to each hydrologic soil group;
e) pre and post-development flows;
f) storage volumes associated with pre and post-development runoff control measures; and

g) storage-stage curve/graph/table clearly illustrating zones of volume and depth for quality, quantity (erosion and flood control) permanent pool

The study shall describe all the modeling parameters and the criteria for their selection as well as input and output data. To facilitate County review, computer printout from modeling software should appear in readable format to allow proper interpretation. The consultant shall assume full responsibility for the proper application of the hydrologic models.

Note: at orifice/flow control device or in other suitable place (i.e. at outlet headwall stage/water level gauge indicator (scaled "0 meters" at the bottom of SWM facility and in 10 cm increments) to be installed/attached firmly.

TABLE H1
COMPREHENSIVE LIST OF AVAILABLE SWMP'S

Stormwater Management Technique	Haldimand County Perspective[1]
Alternative Development Standards	Not currently endorsed
Source Controls	
• roof leader discharge to surface at front of dwelling	Encouraged
• roof leader and sump pumps discharge to soakaway pits	Discouraged in residential land use due to maintenance and impacts on use of rear yards
• rear yard ponding	Not currently endorsed
• rooftop storage • parking lot storage	Applicable for peak flow control only in industrial/commercial applications.
Conveyance Controls	
• pervious pipe systems • pervious catchbasins	Not currently endorsed
• grassed swales (semi-urban road sections)	Encouraged where applicable
• oversized pipes (Superpipes)	Appropriate in redevelopment of existing areas only.
End-of-Pipe Facilities[2]	
• wetlands • wet ponds	Applicable for water quality/quantity treatment
• dry ponds	Applicable for water quantity control only
• infiltration basins	Site Specific Consideration
• infiltration trenches	Site Specific Consideration
• filter strips	Only considered appropriate for low density, small drainage areas
• buffer strips	Only considered appropriate for low density, small drainage areas
• oil/grit separators and equivalent systems	Applicable; most appropriate for Commercial/Industrial land use; require consideration of treatment train philosophy

[1] The use of any of the foregoing SWMP's is subject to appropriate soil conditions.
[2] The County requires appropriate signage for all surface end-of-pipe techniques.

H 1.04 SEDIMENT AND EROSION CONTROL DURING CONSTRUCTION

CRITERIA

New urban developments generally produce increased sediment loading to the surrounding streams particularly during construction. In order to avoid the inherent detrimental side effects from development (i.e. poor water quality and aesthetics, restricted channel conveyance etc.), it is recommended that sediment control measures be instituted. Some of these measures typically include, sediment traps (temporary or permanent), vegetation screens, catch basin filter bags ("silt sacks") and phased stripping of developable lands. In all cases, it is recommended that sediment loading be controlled as per guidelines published by the Greater Golden Horseshoe Conservation Authorities "Erosion & Sediment Control Guideline for Urban Construction", as amended.

DESIGN

As a minimum all Erosion and Sediment Control Plans should incorporate recommendations and protection measures pertaining to:

- Construction Scheduling;
- Minimizing soil exposure and re-establishment of vegetative cover;
- On-site sediment and erosion techniques;
- Site Supervision;
- Monitoring and Maintenance;
- Site Restoration;
- Special Considerations (i.e. in-stream construction/crossings, fisheries timing constraints); and
- The OPSD drawings in section 200 may assist in the erosion and sediment control specifications.

H 2.00 WATERSHED AREA

The watershed area shall be determined from contour plans and site inspection and shall include all areas that naturally drain into the system and any fringe areas not accommodated in adjacent storm drainage systems, as well as other areas which may become tributary by reason of re-grading. The information shall be confirmed with the Engineering Division prior to the start of the design of the internal servicing of the site.

H 3.00 STORM DRAINAGE PLANS

H 3.01 EXTERNAL AREAS

A plan shall be prepared to a scale of 1:1000 or 1:2000 dependent upon the size of the watershed area, to show the nature of the drainage of the lands surrounding the development site and to show all external drainage areas that are contributory to the drainage system for the development. The external drainage areas shall be divided into smaller tributary areas and the area and the location to which the tributary area is considered in the design shall be clearly shown. The plan shall clearly show all existing contours used to justify the limits of the external drainage area.

In lieu of precise information on development on the whole or any part of a watershed area, the latest zoning by-law and Official Plan issued by the Planning Department shall be used for all external areas in the design and to determine the specific areas to which these values apply.

This external drainage area plan shall be prepared and shall be submitted at the functional report stage and prior to the commencement of the detailed storm sewer design.

H 3.02 INTERNAL DRAINAGE PLAN

All internal storm drainage plans shall be prepared to a scale of 1:1000 and shall include all streets, lots, blocks and other lands within the development. The proposed storm sewer system shall be shown on this plan with all manholes numbered consecutively from the outlet.

These manholes shall be the tributary points in the design and the area contributing to each manhole shall be clearly outlined on this plan. The area, in hectares, of each contributing area (to the nearest tenth) and the runoff co-efficient used shall be shown in a circle located within the contributing area. In cases where areas of different runoff co-efficients may be tributary to the same manhole, the areas and the co-efficients shall be separately indicated on the plan.

In determining the tributary area to each manhole, the proposed grading of the lots must be considered to maintain consistency in the design.

In the case of large areas under single ownership of blocks requiring future site plan agreements, the design shall be prepared on the basis of the whole area being contributory to one manhole in the abutting storm sewer unless more than one private storm connection is necessary to serve the property in which case the appropriate area tributary to

each connection shall be clearly shown and taken into account in the storm sewer design.

The length, size and grade of each section of storm sewer shall also be shown on the storm drainage plan.

H 4.00 STORM SEWER DESIGN

H 4.01 DESIGN FLOWS

The design flow, in each manhole length of sewer, shall be computed on design sheets in the format recommended by MOE guidelines (attached at the end of this section), according to the Rational Formula: Q=0.002778 CIA where:

A = contributing drainage area (hectares)
I = rainfall intensity (mm/hr)
C = runoff co-efficient (dimensionless)
Q = volume of runoff (cubic metres per second)
0.002778 is a constant

H 4.02 RAINFALL INTENSITY

The County has prepared local IDF relationships based on local rainfall patterns. The IDF curves (found at the back of this section) and/or the information that they represent is to be utilized for all stormwater design.

For normal residential and industrial developments, the rainfall intensity shall be determined from the formula indicated on the IDF Curve chart for the respective storm for the 5 year Storm (for developments extending from any existing 2-year system, a two-year storm shall be used).

A 10 minutes inlet entry time at the head of the system for residential developments and a 5-minute inlet entry time for industrial developments should be utilized in the calculations.

For high value commercial and existing heavily developed urban areas, the rainfall intensity shall be determined from the formula indicated on the IDF Curve chart for the respective 10 year Storm.

A 5-minute inlet entry time shall be used at the head of the system.

The 25-Year Storm shall be used as a minimum for all culvert, watercourse and major trunk sewer design. Larger storms are used for roads other that local residential, dependent upon their function. For example, a 50-year storm is typically used for all Arterial and some

Collector roads

H 4.03 MAJOR SYSTEM /OVERLAND FLOW ROUTE

The depths of flooding permitted on streets, while acting as part of the minor drainage system, are generally designed for the 5-year storm, as follows:

a) Flooding shall be limited to 150mm above centreline on local roads and/or shall be contained within the road allowance;

b) On collector roads, the flow spread must leave one lane free of water; and

c) On arterial roads, the flow spread must leave one lane in each direction free of water

The overland flow for a 100-year event shall be accommodated in road cross-sections and /or in blocks of land dedicated to the municipality. Complete design calculations and plans shall be prepared and submitted for approval.

H 4.04 RUNOFF CO-EFFICIENTS

Minimum Runoff co-efficients to be used in storm sewer design shall be as follows:

a) Based on the description of Area:

Parks over 4 hectares	0.20
Parks 4 hectares and under	0.25
Single Family Residential	0.45
Single Family Residential (Lot size less than 12.2m)	0.60
Semi-detached Residential	0.60
Townhouses, Maisonette, Row Houses, etc.	0.75
Apartments	0.75
Schools and Churches	0.75
Industrial	0.80
Commercial	0.90
Heavily Developed Areas	0.90

b) Based on character of Surface:

Pavement: - Asphalt and Concrete	0.95
- Stone, brick and precast concrete Paving panels:	
with sealed joints	0.85
with open joints	0.65
- Gravel road and shoulder	0.70
Roofs	0.95

RUNOFF COEFFICIENTS FOR RURAL AREAS

Lawns	Sandy Soil	Heavy Clay Soil
Flat 0 – 2%	0.05 to 0.10	0.13 to 0.17
Average – 2% - 7%	0.10 to 0.15	0.18 to 0.22
Steep - > 7%	0.15 to 0.20	0.25 to 0.35

The runoff coefficients (C) listed above are applicable for storm 2, 5 and 10-year frequencies. For less frequent storms Antecedent Precipitation Factor (Ca) should be used and Rational Formula to be modified accordingly to:

$Q = Ca \times C \times I \times A$

'Ca' value are listed below:

2 to 10 year storm - Ca = 1.00
25 year storm - Ca = 1.10
50 year storm - Ca = 1.20
100 year storm - Ca = 1.25

and the product of 'Ca x C' should not exceed 1.00

H 4.05 IMPERVIOUSNESS

Impervious values for overall storm analysis and modelling of new development should reflect maximum impervious coverage through Zoning By – Law regulations.

Usually, the increases in imperviousness from a pre- to a post-development condition are approximately:

- for residential development - 55%
- for commercial and industrial development - 85%

Development submissions reflecting an imperviousness increase of less than the values noted above will require clear justification.

H 4.06 TIME OF CONCENTRATION

The preferred method to calculate time of concentration of the overland flow in the pre-development condition, if the runoff coefficient is less than 0.40, is the Airport Formula.

Airport Formula

$$T_C = \frac{3.26(1.1-C)L^{0.5}}{S_w^{0.33}}$$

T_C = Time of Concentration (minutes)
C = Runoff Coefficient (dimensionless)
L = Watershed Length (metres)
S_w = Watershed Slope % (m/m)

H 4.07 PIPE CAPACITIES

Manning's formula shall be used in determining the capacity (based on nominal diameters) of all storm sewers. The capacity of the sewer shall be determined on the basis of the pipe flowing full, but the design flows should not exceed 90% of full capacity.

The value of the roughness co-efficient 'n' used in the Manning's formula shall be as follows:

(a)	Concrete Pipe all sizes	0.013
(b)	Concrete Box Culverts	0.013
(c)	Corrugated Metal 13mm corrugations	0.024
(d)	Corrugated Metal 25% paved invert	0.021
(e)	All smooth walled pipe materials	0.013

H 4.08 FLOW VELOCITIES

Minimum acceptable velocity = 0.75m/sec
Maximum acceptable velocity = 4.6m/sec

H 4.09 MINIMUM SIZES AND SLOPES AND FLOW CONTROL DEVICES

The minimum pipe size for a storm sewer is 300mm. For sites requiring outlet controls, orifice plates are to be used. For infrastructure to be assumed by the County, preferable minimum orifice size is to be 100mm diameter (per MOE Manuals 2003). 75mm diameter is considered to acceptable (absolute minimum in order to prevent clogging of the operation). Flow control devices (orifice) shall be installed on the upstream side of the manhole. Regardless of flow velocities obtained,

the minimum design grades for pipe storm sewers shall be as follows:

Sewer Size	Minimum Grade
300mm to 375mm	0.35%
450mm to 525mm	0.25%
600mm to 900mm	0.15%
975mm to 1200mm	0.10%
1350mm and over	0.05%

H 4.10 MINIMUM COVER

The depth of the storm sewer shall be sufficient to provide frost protection. The minimum cover to the top outside pipe barrel of a shallow storm sewer system shall in no case be less than 1.3 metres from the centreline of the roadway.

If the proposed system has less than 1.3m cover, then the proper insulation shall be provided in accordance with MOE guidelines. Supporting calculations must be provided.

H 4.11 LOCATION

The storm sewers shall be located as shown on the Haldimand County Standard Cross Section Drawings G1-G4. In the case of crescents, looped and curvilinear streets, this standard location may be varied to the extent that the storm sewer remains on the same side of the centreline of the street (i.e., left or right) to avoid crossing the sanitary sewer trenches at the changes in direction of the street.

H 4.12 DEEP AND SHALLOW STORM SEWERS IN RURAL SUBDIVISIONS

For Rural Estate Subdivision Road Cross-sections in the rural areas, a shallow storm sewer system will be permitted provided the lot sizes are equal to or in excess of 0.20 hectares (i.e. partial storm systems in roads with ditches).

The design criteria are largely intended for greenfield development and is to be adhered to in those instances. For retrofit projects in existing areas, the criteria must be considered, but these retrofit developments will be constructed on a most-practicable basis.

Catchbasin manholes will be permitted in shallow storm sewer systems.

H 4.13 CURVED SEWERS

Radial pipe shall be allowed for all storm sewers 1000mm in diameter and larger, providing that a manhole is located at the beginning or at

the end of the radial section. The minimum centreline radius allowable shall be 15 times the pipe diameter.

H 4.14 LIMITS

All sewers shall be terminated at the upstream subdivision limit when external drainage areas are considered in the design with suitable provision in the design of the terminal manholes to allow for the future extension of the sewer.

When external areas are not included in the sewer design, the sewer shall extend at least half way across the frontage and/or flankage of any lot or block in the subdivision.

H 4.15 SEWER ALIGNMENT

All storm sewers shall be laid in a straight line between manholes unless radial pipe has been designed. The maximum change in direction of flow in manholes for sewer sizes 1000mm diameter and over shall be 45 degrees.

H 4.16 PIPE CROSSINGS

A minimum clearance of 0.15 metres shall be provided between the outside of all pipe barrels at all points of crossing. In cases where the storm sewer crosses a recent utility trench at an elevation higher than the elevation of the utility, a support system shall be designed to prevent settlements of the storm sewer, or alternatively the original trench will be re-excavated to the top of the utility and shall be backfilled with compacted crushed stone or concrete to adequately support the storm sewer. When the storm sewer passes under an existing utility, adequate support shall be provided for the utility during and after construction to prevent damage to that utility.

H 4.17 CHANGES IN PIPE SIZES

No decrease of pipe size from a larger upstream to a smaller size downstream will be allowed regardless of the increase in grade (capacity).

H 4.18 HEAD LOSSES

Suitable drops shall be provided across all manholes to compensate for the loss in energy due to the change in flow velocity and for the difference in the depth of flow in the sewers.

Hydraulic calculations shall be submitted for all junction and transition manholes on sewers where the outlet is 1050mm or greater. In addition, hydraulic calculations may be required for manholes where the outlet pipe is less than 1050mm diameter if, in the opinion of the Manager of Engineering, there is insufficient invert drop provided across any manhole.

Regardless of the invert drop across a manhole as required by calculations, the obvert of the outlet pipe shall not be higher than the obvert of the inlet pipes at any manhole location.

The minimum drop across manholes shall be as follows:

Change of Direction	**Minimum Drop (mm)**
0	20
1 degree to 45 degrees	50
46 degrees to 90 degrees	80

H 5.00 SEWER PIPE

H 5.01 MATERIALS

Storm sewers shall be constructed of concrete and PVC pipe meeting OPSS standards. Concrete pipe is preferred for Storm Sewers; however PVC will be accepted for sizes up to 600mm. The type and classification of all storm sewer pipe and the sewer bedding type shall be clearly indicated on all profile drawings for each sewer length.

All sewers shall be designed for an embankment condition.

Concrete pipe shall conform to the requirements of C.S.A. Specification A257 for the particular classes as shown below:

a) Class 3 non-reinforced concrete pipe, CSA Standard A257.1

b) Reinforced concrete pipe, CSA Standard A257.2.

H 5.02 PIPE BEDDING

The class of pipe and the type of bedding shall be selected to suit loading and proposed construction conditions. Generally, all pipes are to be designed assuming an embankment condition. Details of the types of bedding are as illustrated in the Ontario Provincial Standard Drawings. In general, Granular A compacted to 95% Proctor Density to

springline with a minimum 300mm sand cover shall be used for storm sewers in new developments.

H 6.00 MANHOLES

H 6.01 MAXIMUM SPACING

The maximum spacing between manholes shall be as follows:

Pipe Size	Maximum Manhole Spacing
300mm	95 metres
375mm to 750mm	100 metres
825mm to 1200mm	125 metres
1200mm and over	150 metres

Manholes are required at all mainline pipe junctions, changes in grade or changes in alignment.

H 6.02 MANHOLES TYPES

Manholes may be constructed of precast or poured concrete. O.P.S.D. details shall be used for manhole design where applicable. Although these Standard Drawings provide details for manholes up to certain maximum depths and sizes, the consulting Engineer shall analyse, individually, each application of the standards relative to soil conditions, loading and other pertinent factors to determine structural suitability. In all cases where the Standard Drawings are not applicable, the manholes shall be individually designed and detailed. Working drawings must be provided for poured-in-place structures.

A reference shall be made on all profile drawings to the type and size of all storm manholes. In the case of the standard 1200mm precast manhole, the size of the manhole may be omitted and reference need only be made to the Standard Drawing number.

H 6.03 MANHOLE DESIGN

(a) All manhole chamber openings shall be located on the side of the manhole parallel to the flow for straight run manholes, or on the upstream side of the manhole at all junctions.

(b) The direction of flow in any manhole shall not be permitted at acute interior angles.

(c) Safety gratings are required at the mid-point depth of manhole, when the depth is between 5.0 and 10.0m. Additional safety

grates are required at third-point depths, when the manhole is equal to or greater than 10.0m to 15.0m deep. All incoming pipes are to be below safety gratings, where possible.

(d) The obverts on the upstream side of manholes shall not be lower than the obvert of the outlet pipe.

(e) Where the difference in elevation between the obvert of the inlet and outlet pipes exceed 0.6m, a drop structure shall be placed on the inlet pipe with the invert of the drop pipe located at the spring line of the outlet pipe. Design should be in conformity with OPSD's.

(f) All storm sewer manholes shall be benched to the obvert of the outlet pipe on a vertical projection from the spring line of the sewer.

(g) The minimum width of benching in all manholes shall be 230mm.

(h) Manholes in boulevards shall be located, wherever possible, a minimum of 1.5m distant from the face of curb or other service.

H 6.04 GRADES FOR MANHOLE FRAME AND COVERS

All manholes located within the travelled portion of roadway shall have the rim elevation set flush with the surface of the base course asphalt. The bricking and setting of the frame and cover shall be completed in accordance with the details provided in the Ontario Provincial Standard Drawings. After final application of surface asphalt the manhole frame and grates shall be adjusted to surface elevation through a poured in place concrete ring. The concrete ring shall be constructed through coring through the full depth of the asphalt. The frame and grate shall be set to match the elevation and crossfall of the final asphalt grade. A sono tube form shall be installed as to match the manhole chimney opening. The concrete shall be placed neat to the edge of the asphalt core and shall be trowelled as to match the existing lines and grade of the asphalt surface. The surface of the concrete shall receive a brushed finish.

Alternatively a Mueller model "the Adjustable" or equivalent manhole frame and cover may be used. Installation of the manhole frame and grate shall be as per the manufacturers instructions. Units shall consist of three components, a cover, frame and guide.

H 7.00 CATCHBASINS

H 7.01 LOCATION AND SPACING

Catchbasins shall be selected, located and spaced in accordance with the conditions of design. The design of the catchbasin location and type shall take into consideration the lot areas, the lot grades, pavement widths, road grades and intersection locations. The recommended maximum catchbasin spacings are as follows:

Pavement Width	**Road Grade**	**Maximum Spacing**
8.5m	Up to 4%	95m
8.5m	Over 4%	69m
10.0m	Up to 4%	84m
10.0m	Over 4%	61m
11 m	Up to 3.5%	76m
11 m	Over 3.5%	53m
14 m	Up to 3%	61m
14 m	Over 3%	46m

Catchbasins shall be generally located upstream of sidewalk crossings at intersections and upstream of all pedestrian crossings, at the ends of the curb returns. Catchbasins shall not be located in driveway curb depressions, if at all possible.

Double catchbasins shall be normally required when the catchbasin intercepts flow from more than one direction. Single catchbasins may be used in the case where the total length of drainage to the catchbasin, from both directions, is less than 95m.

Rear lot catchbasins and connections shall be located as outlined in Section L 2.01, but are to be used only when no other options are available. Appropriate easements would be required. Generally, a 3m minimum width (dependent upon depth) would suffice. Preference shall be given to other lot grading patterns

H 7.02 CATCHBASIN TYPES

All catchbasin structures shall be constructed in accordance with all Ontario Provincial Standard Specifications and Drawings.

Special catchbasins and inlet structures shall be fully designed and detailed by the Engineer.

H 7.03 CATCHBASIN CONNECTIONS

For single catchbasins, the minimum size of connection shall be 200mm and the minimum grade shall be 1.0%.

For double catchbasins, the minimum size of connection shall be 250 mm and the minimum grade shall be 1.0%.

For rear lot catchbasins, the minimum size of the connection shall be 200mm and the minimum grade shall be 1.0%.

In general, catchbasins leads should be connected to tees in the storm sewer main. Long catchbasin connections (in excess of 23m) shall be connected to a manhole or, alternatively, the lead can be connected to the sewer and a 1200mm manhole catchbasin used in lieu of the normal 600mm square catchbasin.

H 7.04 GRATINGS

In general, the bike-proof catchbasin grate (OPSD 400.100, 400.110) shall be required for all catchbasins located in roadway or walkway areas, and the birdcage type (OPSD 400.120) type shall be used for parks, ditches and rear lot catchbasins.

H 7.05 GRADES FOR CASTINGS AND ADJUSTMENTS

In roadways, the grade for the top of concrete shall be established, as shown on the Standard Drawings. The adjustment to the final elevation shall be made at the time of curb construction.

H 7.06 CATCHBASINS AT INTERSECTIONS

All catchbasins at street intersections shall be located on the tangent section of the curb a minimum of 0.6 metres distant from the beginning or the end of the radial portion of the curb and the grading of the intersection shall provide for drainage to the catchbasins' location.

H 8.00 INLETS, OUTFALLS AND SPECIAL STRUCTURES

H 8.01 GENERAL

Inlet and outlet structures shall be fully designed and detailed on the engineering drawings. The details provided shall include the existing topography, proposed grading and the work necessary to protect against erosion.

H 8.02 INLETS

For other than minor swales, where catchbasins with birdcage tops are used, inlet structures shall be fully designed. Inlet grates shall generally consist of inclined parallel bars or rods set in a plane at approximately 45 degrees with the top downstream in the direction of flow. Gabions, rip-rap or concrete shall be provided at all inlets to protect against erosion and to channel the flow to the inlet structure.

H 8.03 OUTLETS

The O.P.S.D. Standard Headwall shall be used for all storm sewers up to 1800mm. For sewers over 1800mm in diameter, the headwalls shall be individually designed. All headwalls shall be equipped with a horizontal grating over the outlet end of the pipe and a railing across the top of the headwall for the protection of the public. Alternate outlet designs will be considered on a site-specific basis.

All outlets shall discharge in the direction of flow of the watercourse, with the directional change being taken up in the sewer rather than the channel.

Gabions, rip-rap, concrete or other erosion protection shall be provided at all outlets to prevent erosion of the watercourse and to the area adjacent to the outlet. The extent of the erosion protection shall be indicated on the engineering drawings and shall be dependent upon the velocity of the flow in the storm sewer outlet, the soil conditions, the flow in the existing watercourse, site conditions, and the requirements of the appropriate Conservation Authority, if applicable.

H 8.04 OPEN CHANNELS

The proposed criteria for an open channel design shall be submitted by the Consulting Engineer to the Engineering Manager for his approval, prior to the actual design being undertaken. The Consulting Engineer shall also be responsible for obtaining the approval of the design from the Ministry of Natural Resources, the Department of Fisheries and Oceans and the local Conservation Authority. Generally, the stream alignment and erosion control features should follow a natural path.

H 9.00 CONSTRUCTION

Construction of all storm sewers and appurtenances shall be in accordance with the OPSS's and OPSD's at the time of approval of the design drawings by the Engineering Manager.

TABLE 1
INTENSITY-DURATION-FREQUENCY VALUES
MOUNT HOPE

Duration (min)	Rainfall Intensity (mm/hr)					
	2	**5**	**10**	**25**	**50**	**100**
5	102.7	140.1	165.0	196.3	219.6	242.4
10	72.1	100.4	119.1	142.8	160.4	177.8
15	58.4	81.2	96.3	115.4	129.5	143.6
30	39.6	55.2	65.6	78.6	88.3	97.9
60	24.7	36.2	43.8	53.4	60.6	67.7
120	15.0	22.2	26.9	33.0	37.4	41.9
360	6.6	9.4	11.3	13.6	15.3	17.0
720	3.7	5.2	6.2	7.5	8.4	9.3
1440	2.2	3.0	3.5	4.2	4.6	5.1

TABLE 2
IDF PARAMETERS - MOUNT HOPE

Parameter	2	5	10	25	50	100
A	646.0	1049.5	1343.7	1719.5	1954.8	2317.4
B	6.0	8.0	9.0	10.0	10.0	11.0
C	0.781	0.803	0.814	0.823	0.826	0.836

TABLE 3.1
3 HOUR CHICAGO DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	**5**	**10**	**25**	**50**	**100**
10	2.85	3.90	4.57	5.46	6.03	6.61
20	3.20	4.41	5.20	6.23	6.89	7.57
30	3.67	5.10	6.04	7.26	8.04	8.89
40	4.32	6.07	7.23	8.74	9.69	10.77
50	5.29	7.55	9.06	11.02	12.24	13.70
60	6.93	10.08	12.20	14.96	16.65	18.78
70	10.32	15.37	18.80	23.26	25.95	29.53
80	21.58	32.79	40.38	50.04	56.09	63.97
90	73.99	103.04	122.29	146.10	164.61	181.81
100	22.24	33.80	41.62	51.58	57.82	65.94
110	10.92	16.31	19.98	24.74	27.61	31.44
120	7.38	10.77	13.06	16.04	17.86	20.17
130	5.64	8.09	9.72	11.85	13.16	14.76
140	4.60	6.51	7.76	9.41	10.44	11.62
150	3.91	5.47	6.48	7.82	8.66	9.59
160	3.42	4.73	5.58	6.70	7.42	8.17
170	3.04	4.18	4.91	5.87	6.49	7.13
180	2.75	3.75	4.39	5.24	5.79	6.33

G:\WORK\104034\WATER\DWG\MNTHOPE.dwg

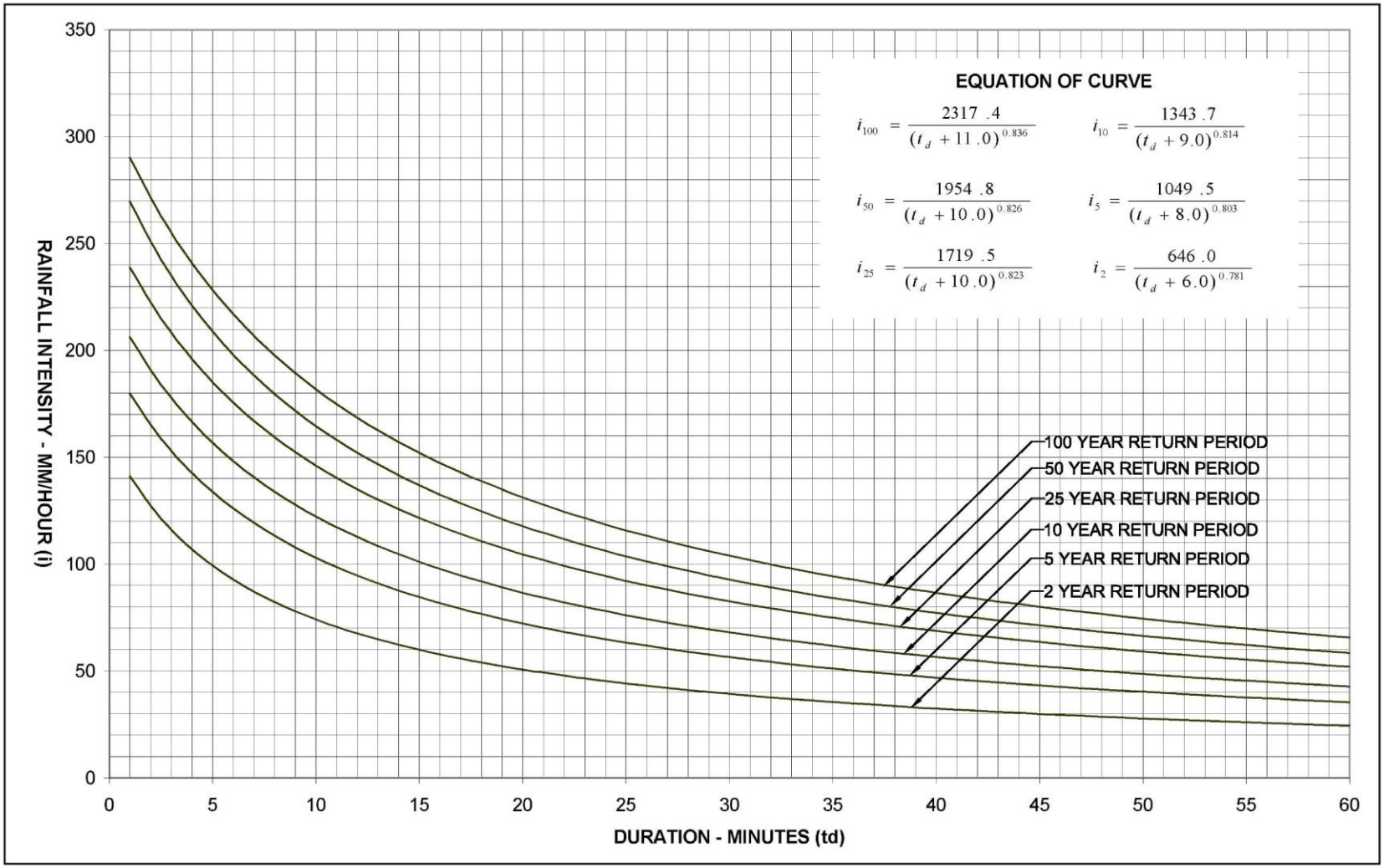
HALDIMAND COUNTY

INTENSITY-DURATION-FREQUENCY RAINFALL CURVES

METRIC

GAUGE: MOUNT HOPE

DATE: NOVEMBER 2004



NOV.25/04 – MS

STORM SEWER DESIGN SHEET

Q 2.78 AIR

Where Q peak flow in litres per second (L/s)

A area in hectares (ha)

I rainfall intensity in millimetres per hour (mm/h)

R runoff coefficient

LOCATION			AREAS (ha)			Indiv. 2.78 AR	Accum 2.78 AR	Time of Conc.	Rainfall Intensity I	Peak Flow Q (L/s)	SEWER DATA							
STREET	FROM	TO	R =	R =	R =						Diameter (mm)	Slope (%)	Length (m)	Capacity (L/s) n =	Velocity (m/s)	Time of Flow (minutes)		

DESIGN	PROJECT	SHEET No.
CHECKED		
DAT		